



Water exchange of an archipelago-like estuary

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In the Baltic archipelagos there exists widely varying length scales, from narrow straits to wide land-locked basins. A numerical model approach has been formulated and validated against long-term salinity and temperature data assessed from 1981 through 2000. This model subdivides the Himmerfjärden study area into 17 basins with 38 interconnecting straits, of which 16 are parallel to one (or more) existing strait(s). Central to this approach is the net volume flow as a function of the net sea level difference between two adjacent basins, making it possible to solve the barotropic dynamics separately from the baroclinic multi-layer exchange. In order to account for the geometric properties of these straits, each one has been subjected to an analysis according to the functional theory of Dalziel (1992). Depending on the wind, freshwater and boundary density fluctuation forcing, the flow through each strait is dynamically classified into four different regimes: (i) rotational, (ii) pure barotropic unidirectional, (iii) bidirectional two-groups-of-layers with aspiration and (iv) plug-flow with no aspiration effects. The latter regime also serves as a resort for the regime (iii) cases for which no numerical solution can be obtained, e.g. when the stratification of the basins requires for three or more groups of layers. A fifth regime applies to a couple of elongated canal-like straits where side and bottom friction effects become apparent. To ensure numerical stability, a smooth transition between these regimes has been ascertained. The response of the basins to the exchanged scalar properties salinity and temperature that determine the density has also been made an integral part of the model, based on the energetic balance between wind-induced mixing and its work against buoyancy forces, and with full consideration to the basins' bathymetry. The ambition is that this model approach should be general enough so that it would be possible to extend it to encompass the entire Stockholm archipelago.